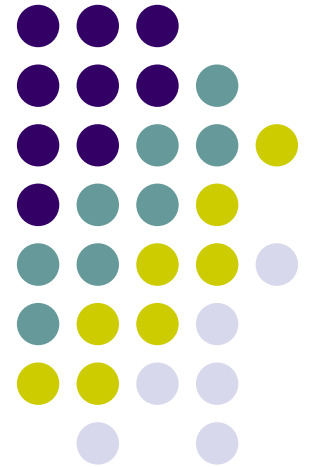


Renewable Energy Technologies for Aquaculture

Barrett T. Vaughan, Ph.D.
G. W. Carver Agricultural
Experiment Station
Tuskegee University



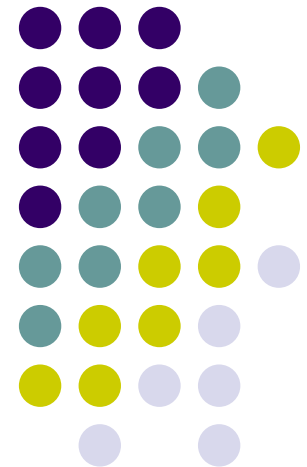
Renewable Energy Technologies for Aquaculture



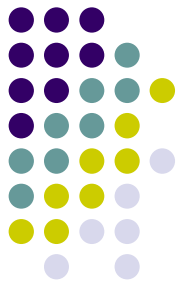
- Energy-Efficient Aeration Setup for Small-Scale Inland Shrimp Farming
- Aerator Electrical Energy Usage Reduction with Solar-Powered Aerators
- Sustainable Energy Options for Pond Aquaculture (SEOPAq) Workshop

Energy-Efficient Aeration Setup for Small-Scale Inland Shrimp Farming

Alabama Department of
Economic and Community Affairs
Agriculture Energy Efficiency
Program Grant

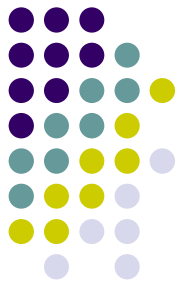


Aeration in Aquaculture



- Maintenance of dissolved oxygen (DO) levels in water
- Nighttime use when phytoplankton are not producing DO
- 8 – 12 hours daily
- Paddlewheel aerator most common

Demonstration Site



- Saltwater shrimp farm (Central AL)
- Two 1-hectare ponds
- Growing season – May 10 to October 7 (150 day season)

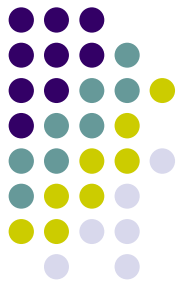


Monitoring System & Equipment



- Monitoring System
 - Oxygen Scan, Control, and Report (OSCAR)
 - Suncoast Systems
 - DO/Temp. Sensor Buoy
 - Activates aerators by timer or when DO is low

Monitoring System & Equipment



- Aerators
 - Primary – 10 HP
 - Supplemental – 5 HP



Negotiated Control Protocol



- Primary 10HP aerator controlled by farmer



Negotiated Control Protocol



- Primary 10HP aerator controlled by farmer
- Supplemental 5HP aerator controlled by monitoring system – $\text{DO} < 4.0 \text{ mg/L}$



Negotiated Control Protocol

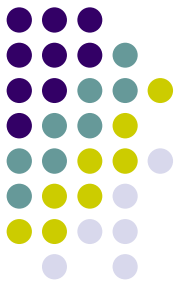


- Primary 10HP aerator controlled by farmer
- Supplemental 5HP aerator controlled by monitoring system – $\text{DO} < 4.0 \text{ mg/L}$
- Primary aerator used midday for pond DO destratification

Negotiated Control Protocol



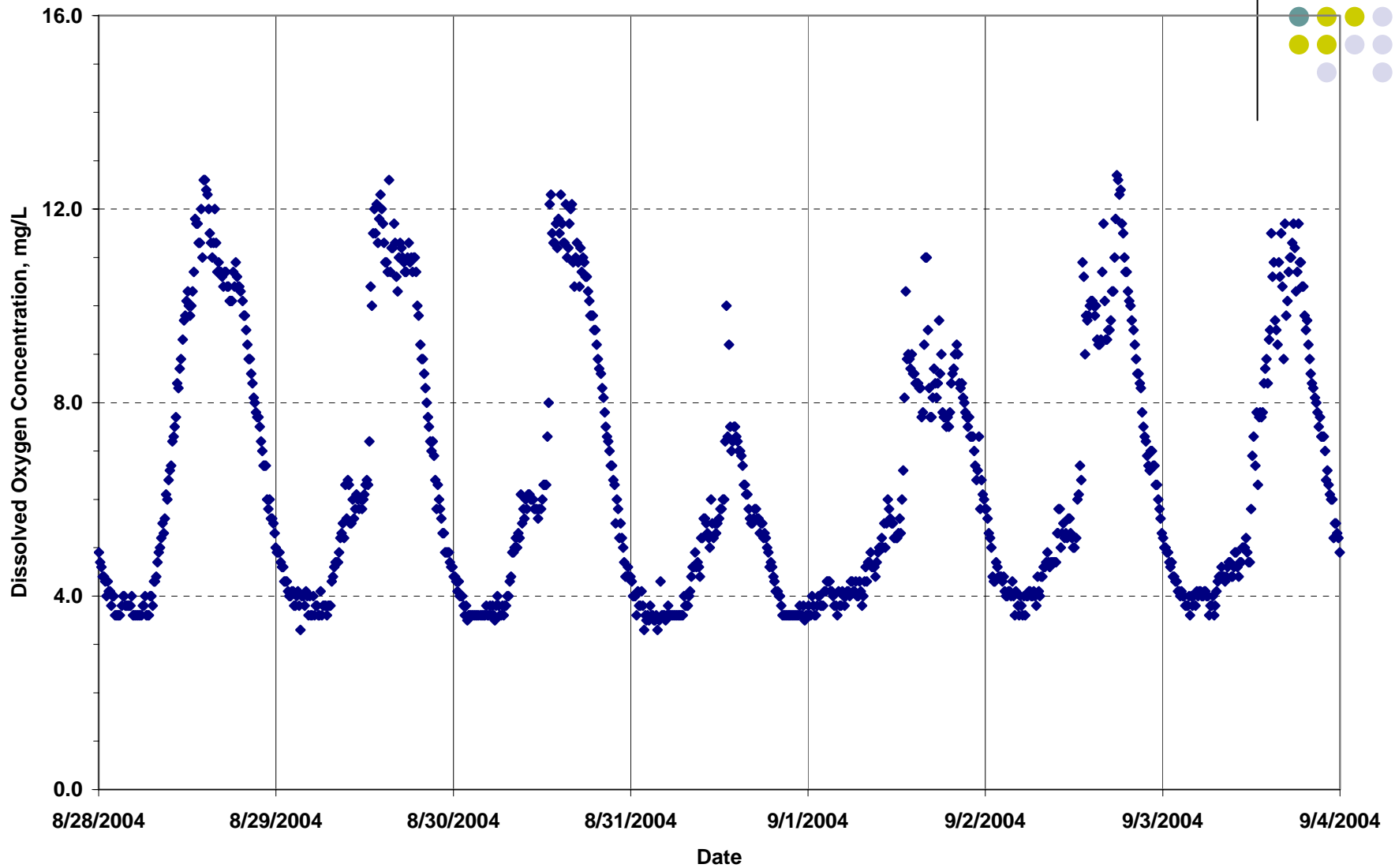
- Primary 10HP aerator controlled by farmer
- Supplemental 5HP aerator controlled by monitoring system – $\text{DO} < 4.0 \text{ mg/L}$
- Primary aerator used midday for pond DO destratification
- Risk Management



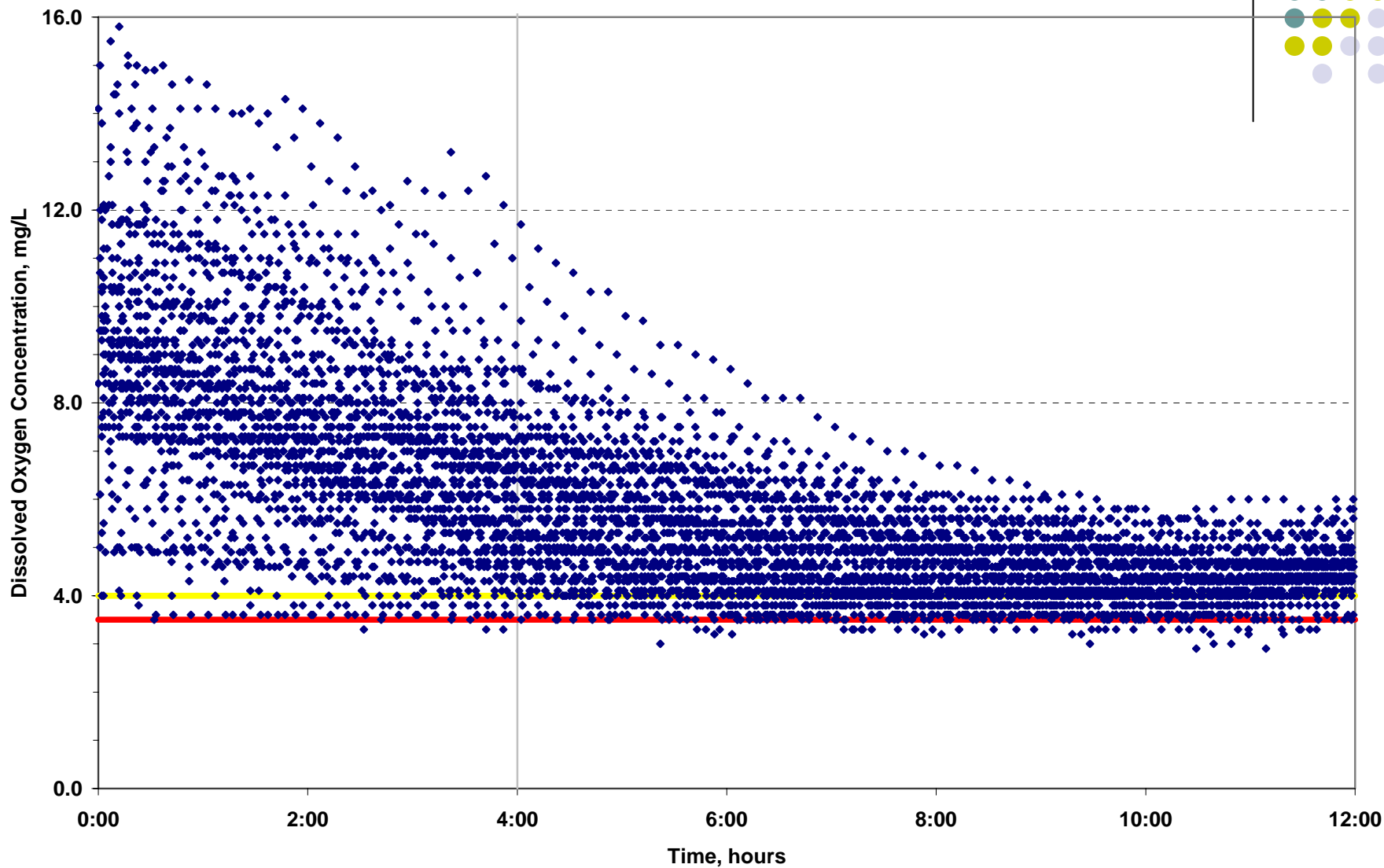
Results

- Nighttime dissolved oxygen concentrations showed typical decreasing trends with time

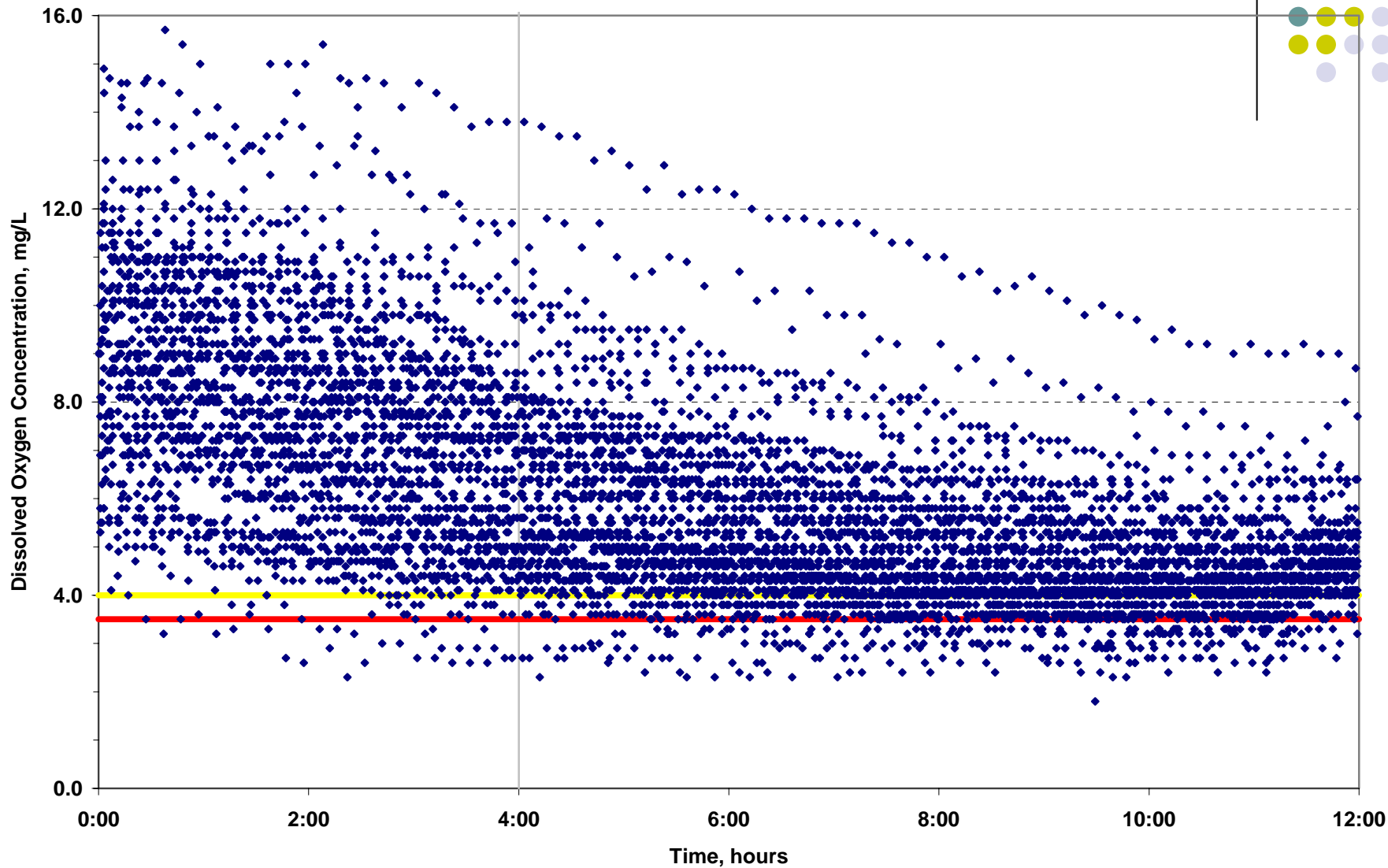
Dissolved Oxygen Concentration



Dissolved Oxygen Concentration (beginning at 8:00 p.m.) in Pond 1



Dissolved Oxygen Concentration (beginning at 8:00 p.m.) in Pond 2

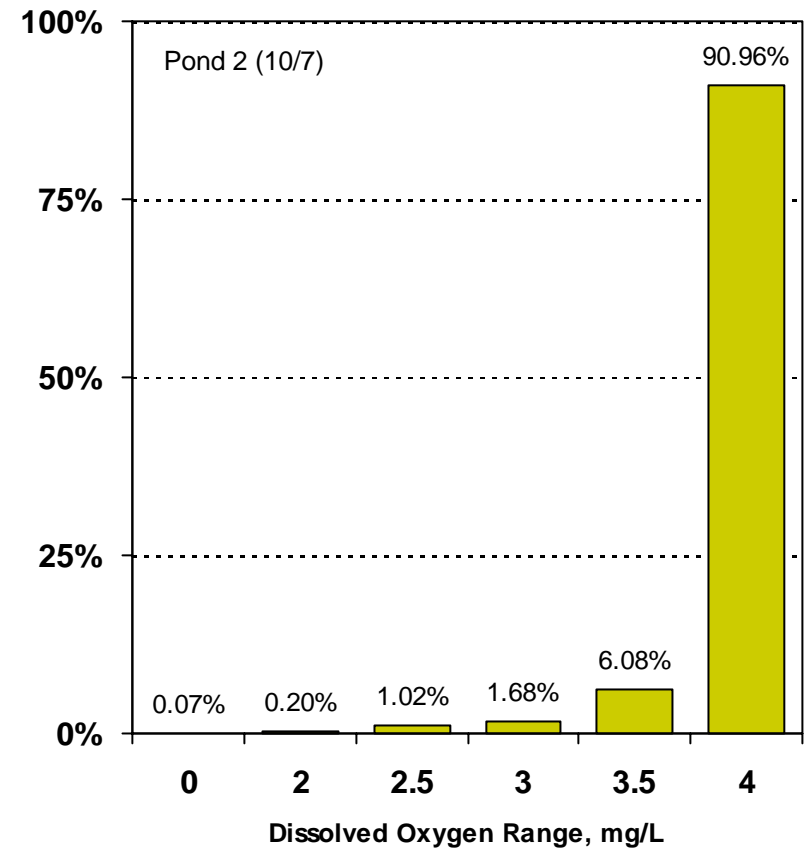
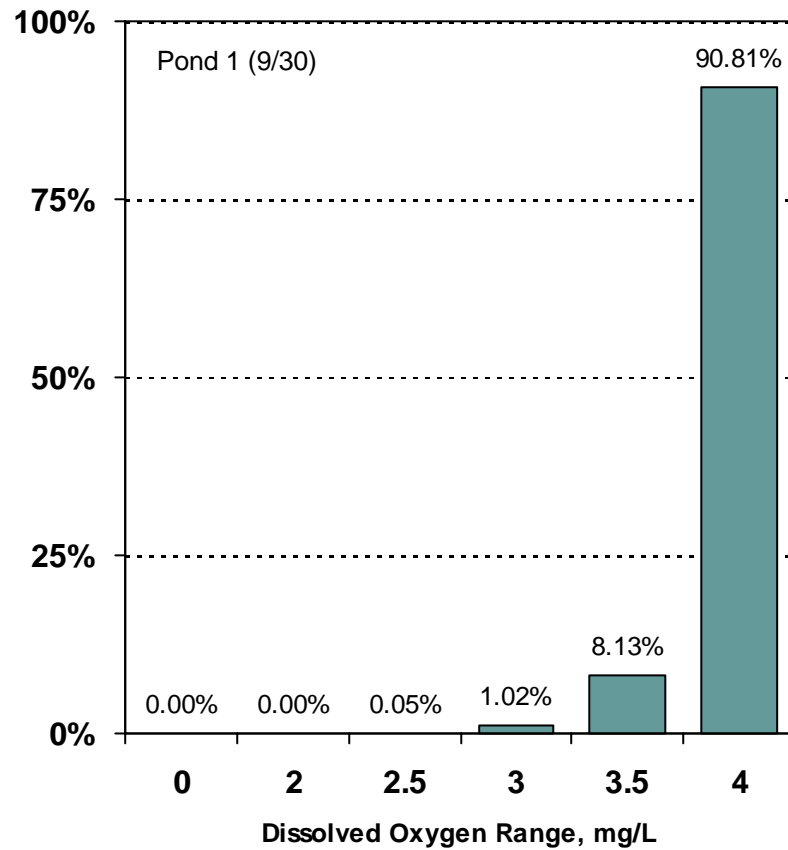


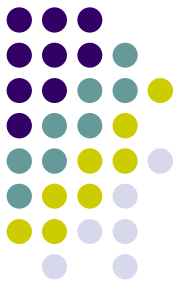
Results



- Dissolved oxygen concentrations stayed above 4.0 mg/L over 90% of the time

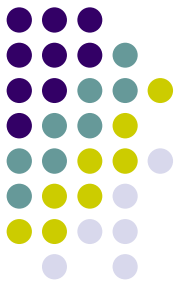
Results





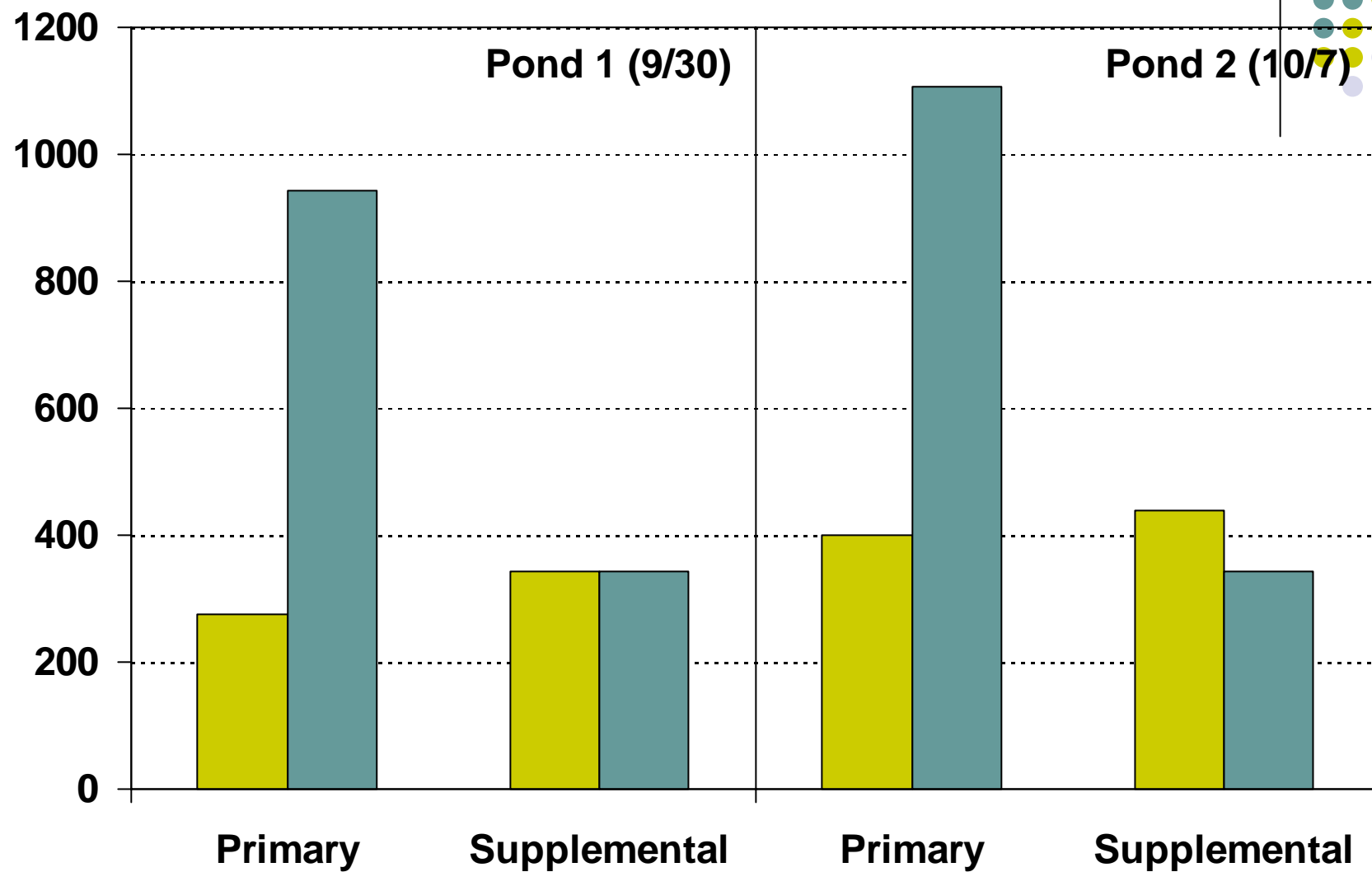
Results

- Primary (10 HP) aerators
 - Majority of usage time (~85%) spent during longer, nighttime intervals, as expected.
 - Majority of activations (~70%) were for short intervals.

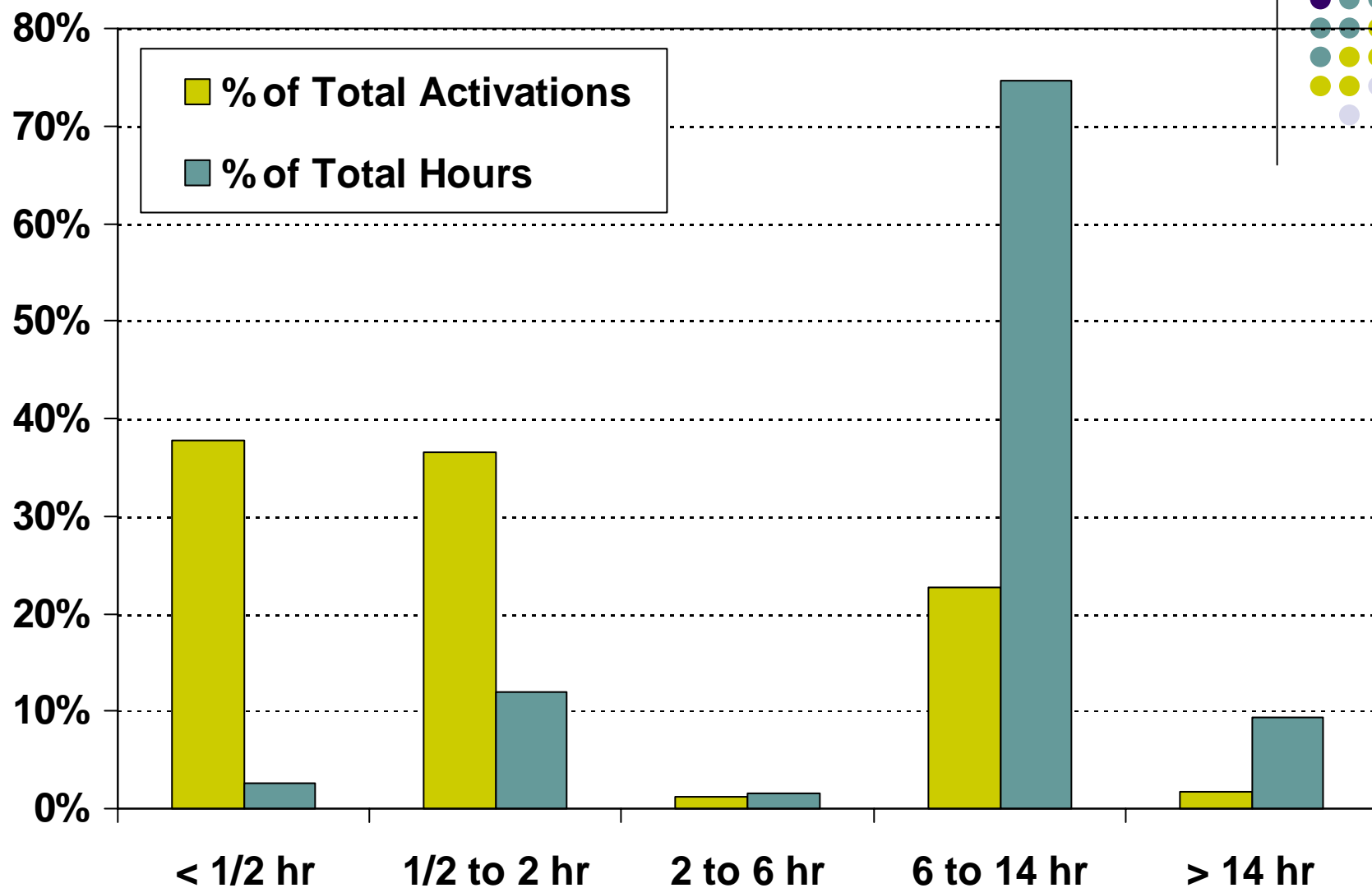


Results

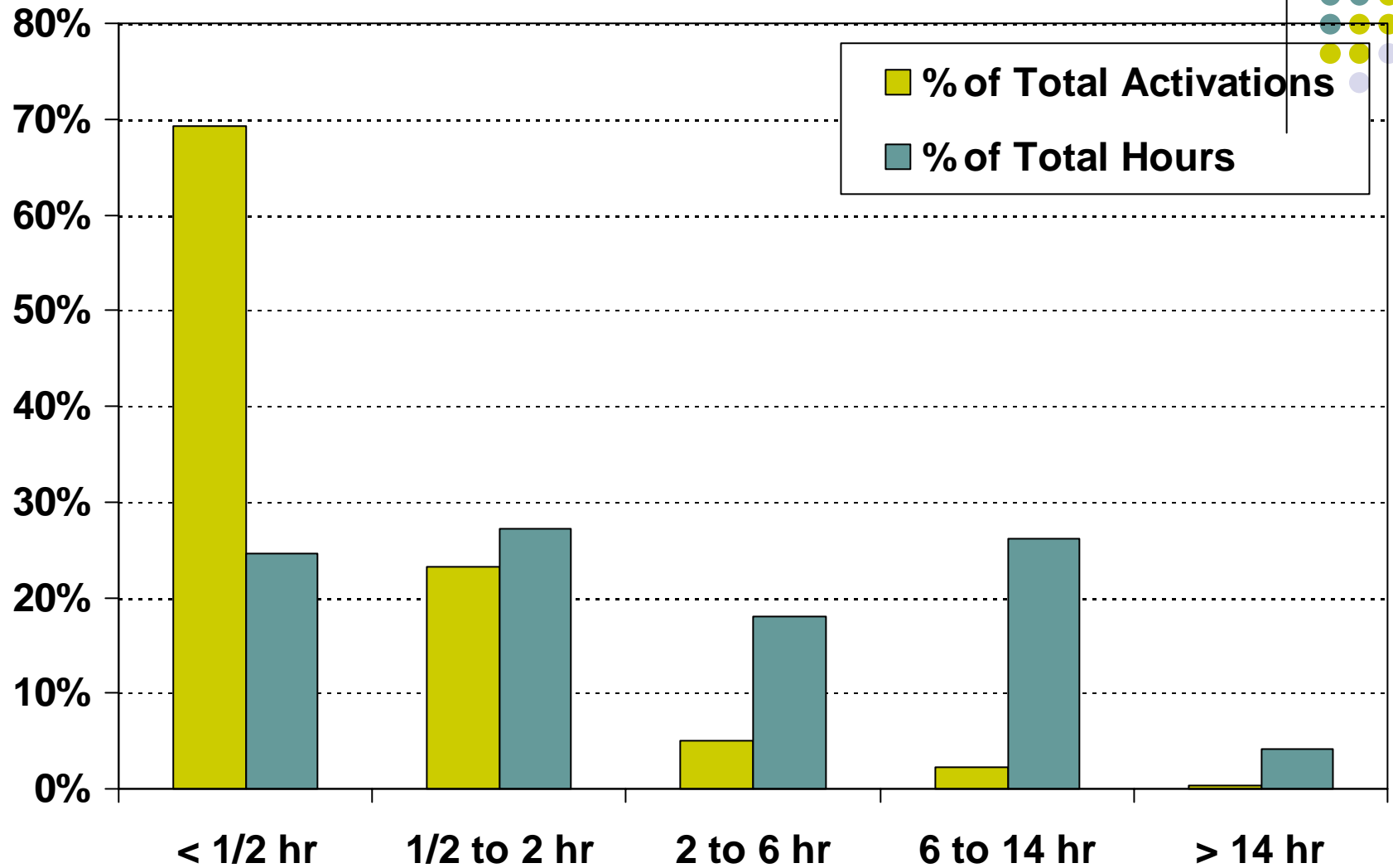
- Supplemental (5 HP) aerators
 - Majority (~90%) of activations were for shorter intervals, as expected.
 - Use for longer, nighttime intervals accounted for almost one-third of the total usage hours.



Primary Aeration (10 HP)



Supplemental Aeration (5 HP)



Summary/Recommendations



- Supplemental aeration is necessary for DO maintenance

Summary/Recommendations



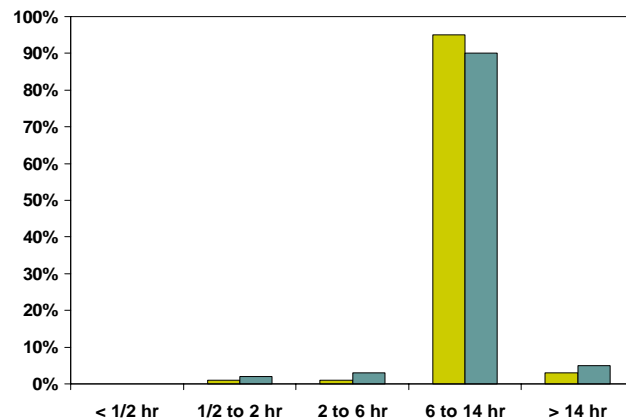
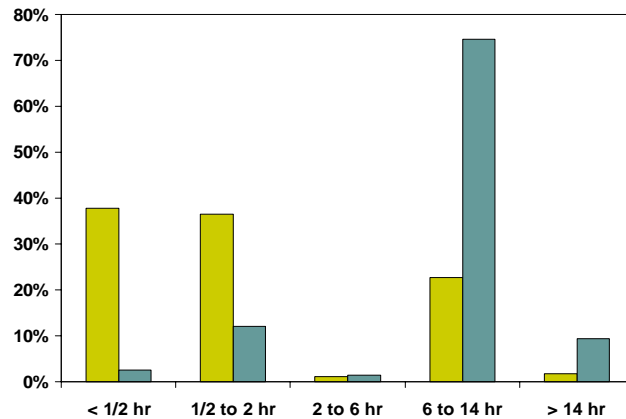
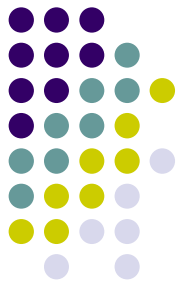
- Supplemental aeration is necessary for DO maintenance
- Activations of primary and supplemental aerators should be minimized

Summary/Recommendations



- Supplemental aeration is necessary for DO maintenance
- Activations of primary and supplemental aerators should be minimized
- Duration of aeration should be specific to the aerator

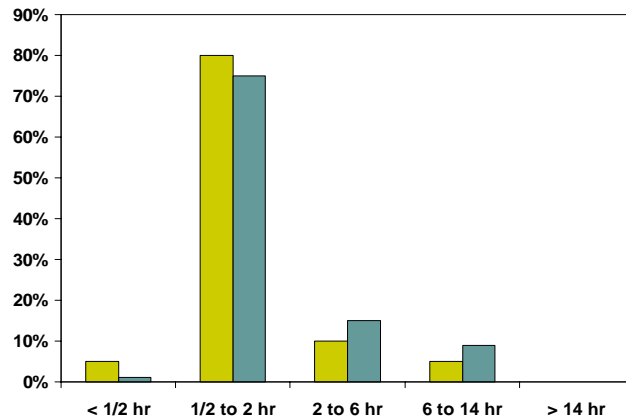
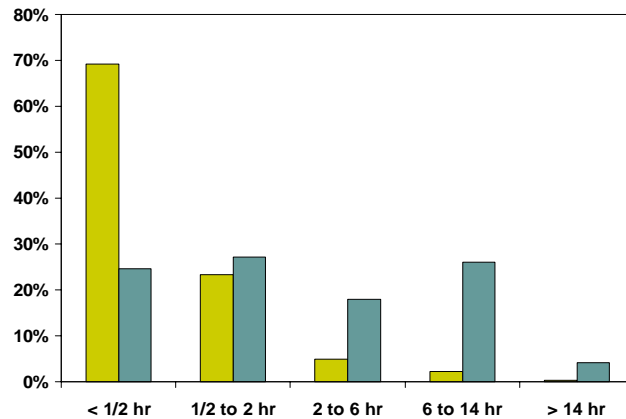
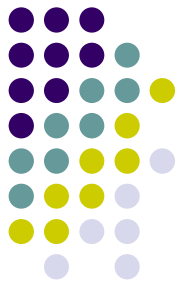
Summary/Recommendations



Primary Aeration

- Continue farmer control and also use system timer
- Decrease shorter use durations (< 6 hr)
- Decrease use for DO destratification

Summary/Recommendations



Supplemental Aeration

- Continue monitoring system control
- Decrease short or long use durations (< 1/2 hr, > 6 hr)
 - Software issue
- Use for midday DO destratification

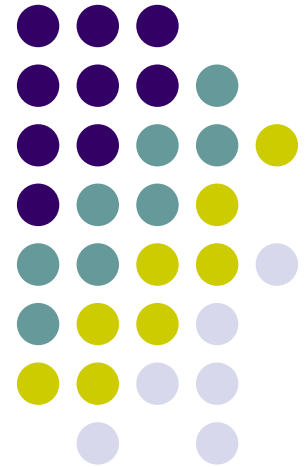
Summary/Recommendations



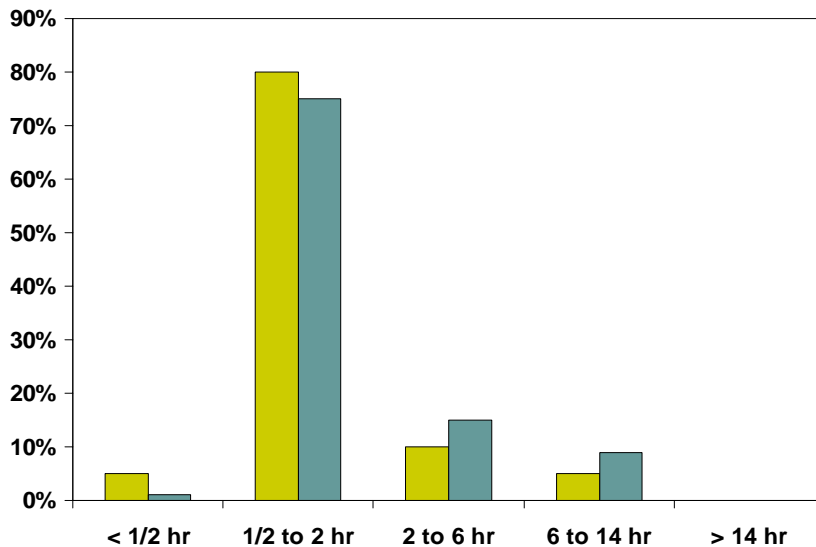
- Supplemental aeration is necessary for DO maintenance
- Activations of primary and supplemental aerators should be minimized
- Duration of aeration should be specific to the aerator
- Pond monitoring systems can be used effectively with good management

Electrical Energy Usage Reduction with Solar- Powered Aerators

Alabama Department of
Economic and Community Affairs
Agricultural Energy Efficiency
Program Grant



Summary/Recommendations



Supplemental Aeration

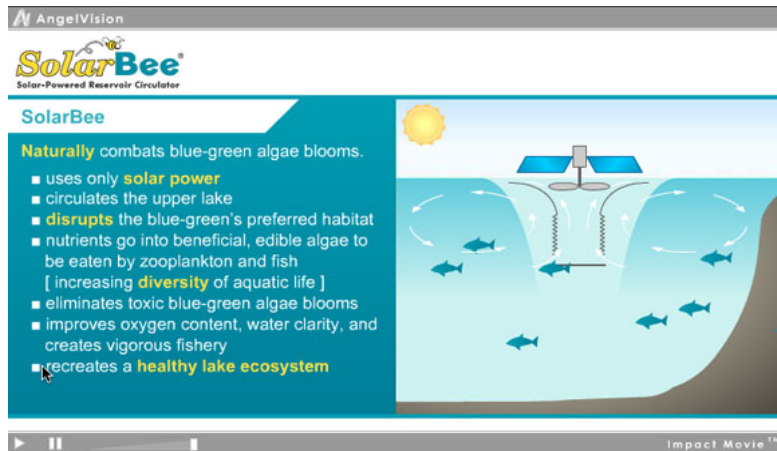
- Use for midday DO destratification
- DO destratification amounts to 10 to 25% of total aerator usage
- Destratification = circulation



Circulation and Energy Use

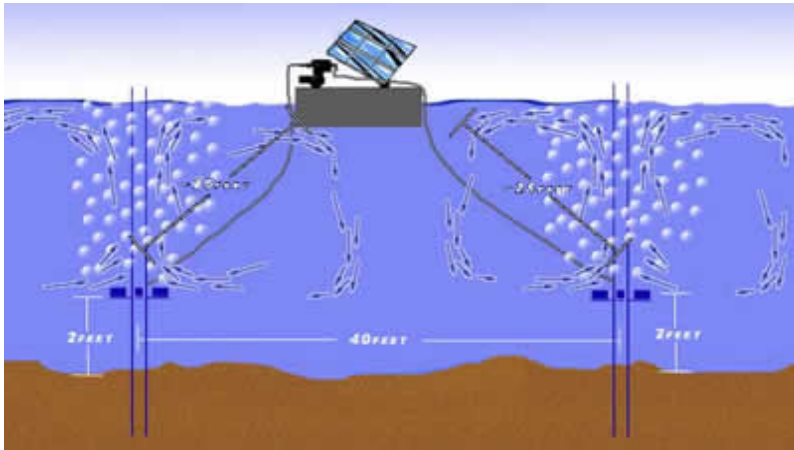
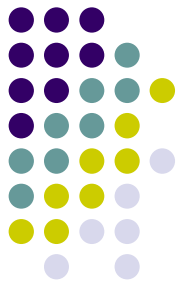
- Boyd (Auburn Univ.)
 - Circulation/aeration benefits
- Moore and Whitis (ACES)
 - Paddlewheel circulation
- Howerton and Boyd (Auburn Univ.)
 - horizontal, axial-flow water circulator
- Tucker and Steeby (Mississippi State)
 - Circulation and aeration reduction

Solar-Powered Mechanical

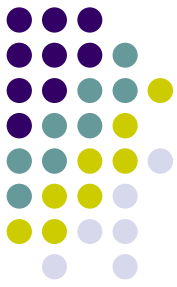


- USDA-ARS Aquaculture Systems Research Unit (AR)
- Green, B.
- SolarBee solar-power mechanical circulator (PSI, ND) and others
- \$13K – 5 acres

Solar-Powered Diffused-Air

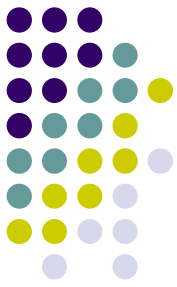


- Tuskegee University
- Vaughan, B.
- AV120-D/N diffused-air aerator airlift (Simpler Solar, FL) and others
- \$3K - ? acres



Demonstrations

- Greene County
 - Catfish
 - circulating with diffused-air aerators
 - Marine shrimp
 - circulating with paddlewheels
- Lowndes County
 - Marine shrimp
 - circulating with paddlewheels

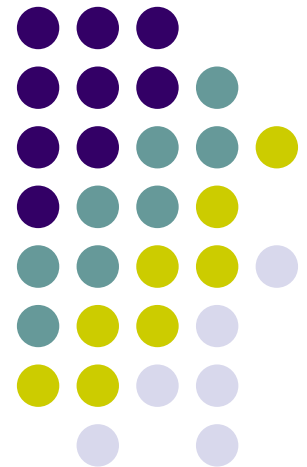


Demonstrations

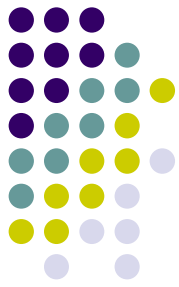
- Solar-powered diffused-air aerators/circulators
 - Pilot scale studies for configuration
 - Field evaluation in seasons 2006 and 2007
 - Quantitative and qualitative comparison with current methods

Sustainable Energy Options for Pond Aquaculture Workshop

Saturday, December 3, 2005
Kellogg Conference Center
Tuskegee University



Energy in Aquaculture Workshop



- A workshop of aquaculture professionals to address energy usage issues in pond aquaculture and develop partnerships for evaluating energy technologies.

Energy in Aquaculture Workshop



- A workshop of aquaculture professionals to address energy usage issues in pond aquaculture and develop partnerships for evaluating energy technologies.
- Funded by a Sustainable Agriculture Research and Education (SARE) Southern Region R & E Planning Grant



Workshop Details

- Presentations, posters, displays, and group discussions are invited on:
 - Energy Use in Aquaculture
 - Aquacultural Economics
 - Pond Monitoring and Aeration Control Equipment
 - Use of Renewable Energy
 - Circulation and Energy Usage
 - Feeding Regimens and Energy Usage

SEOPAg Workshop



- Saturday, December 3, 2005
- Kellogg Conference Center
- Tuskegee University